AMERICAN COKE AND COAL CHEMICALS INSTITUTE

REGULATION OF SOURCES FIRING COKE OVEN GAS UNDER THE INDUSTRIAL COMBUSTION COORDINATED RULEMAKING (ICCR)

Thursday, 30 July 1998

Meeting of ICCR Process Heater Work Group
Renaissance Hotel Long Beach
Long Beach, CA

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on behalf of

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TABLE 1. OVERVIEW OF THE AISI/ACCCI
COKE OVEN ENVIRONMENTAL TASK FORCE (COETF)

- COETF is a joint undertaking of the American Iron and Steel Institute (AISI) and the American Coke and Coal Chemicals Institute (ACCCI).

- COETF represents all 20 domestic companies that produce metallurgical coke:

  - nine integrated steel companies operating 14 coke plants (40 batteries)

  - 11 independently owned/operated "merchant" companies operating 11 coke plants (28 batteries)

- COETF was formed several years ago to address environmental issues of concern to the coke industry.

TABLE 2.
METALLURGICAL COKE PRODUCERS
REPRESENTED BY THE COETF

ABC Coke
Acme Steel Company
AK Steel Corporation
Bethlehem Steel Corporation
Citizens Gas & Coke Utility
Empire Coke Company
Erie Coke Corporation
Geneva Steel
Gulf States Steel, Inc.
Indiana Harbor Coke Company
Koppers Industries, Inc.
LTV Steel Company
National Steel Corporation
New Boston Coke Corporation
Shenango Inc.
Sloss Industries Corporation
Stelco Inc.
Tonawanda Coke Corporation
U. S. Steel
Wheeling-Pittsburgh Steel Corporation

TABLE 3. ACTIVE DOMESTIC COKE PLANTS

STATE	COMPANY	CITY
ALABAMA	ABC Coke (Drummond Company, Inc.)1	Tarrant
	Empire Coke Company1	Holt
	Gulf States Steel, Inc.2	Gadsden
	Sloss Industries1	Birmingham
ILLINOIS	Acme Steel Co.2	Chicago
	Indiana Harbor Coke Company1, 3	East Chicago
	LTV Steel Corp.2	South Chicago
	National Steel Corp.2	Granite City
INDIANA	Bethlehem Steel Corp.2	Burns Harbor
	Citizens Gas & Coke Utility1	Indianapolis
	U.S. Steel2	Gary
KENTUCKY	AK Steel2	Ashland
MICHIGAN	National Steel Corp.2	Ecorse
NEW YORK	Bethlehem Steel Corp.2	Lackawanna
	Tonawanda Coke Corp.1	Tonawanda
OHIO	AK Steel2	Middletown
	LTV Steel Corp.2	Warren
	New Boston Coke Corp.1	New Boston
PENNSYLVANIA	Erie Coke Corp.1	Erie
	Koppers Industries, Inc.1	Monessen
	Shenango Inc.1	Pittsburgh
	U.S. Steel2	Clairton
UTAH	Geneva Steel2	Provo
VIRGINIA	Jewell Coke and Coal1, 3	Vansant
WEST VIRGINIA	Wheeling-Pittsburgh Steel Corp.2	Follansbee

1Plant is an independently owned/operated "merchant" coke plant.
2Plant is owned/operated by an integrated steel company.
3Plant is a nonrecovery coke plant.

TABLE 4. PRESENTATION OVERVIEW

- Review of "ICCR White Paper on Coke Oven Gas" (Dr. Allen C. Dittenhoefer (Enviroplan Consulting))

- Status Report on COETF Review of ICCR Process Heater Database

TABLE 5.
COETF REVIEW OF
<u>ICCR PROCESS HEATER DATABASE</u>

- Database includes 54 "process heaters" operated by 10 coke plants:

  - 24 of these sources are coke oven batteries firing coke oven gas (subject to another MACT standard).

  - 30 remaining sources are still being assessed.

- Review should be completed by mid-August 1998.

ICCR WHITE PAPER ON COKE OVEN GAS

Presented by:

Allen C. Dittenhoefer, Ph. D.
Enviroplan Consulting
Fairfield, NJ

On behalf of:

AISI/ACCCI Coke Oven
Environmental Task Force

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OVERVIEW

The combustion of coke oven gas (COG) results in very low levels of hazardous air pollutant (HAP) emissions similar to those of natural gas combustion:

1. Fuel Composition

2. Fuel Combustion Characteristics/Volatile Organic Emissions

3. Particulate Matter Emissions

4. Petroleum Environmental Research Forum (PERF) Project Results

Fuel Composition

Natural Gas:	Methane (80-95%)
Coke Oven Gas:	Hydrogen (50-60%) Methane (25-30%)

Analytical data indicate that volatile HAP components (e.g., hexane, BTX, naphthalene, etc.) collectively comprise much less than 1% by volume of either natural gas or COG following conventional byproducts recovery.

Fuel Combustion Characteristics/Volatile Organic Emissions

Organic emissions are minimized by combustion practices which promote high combustion temperatures, long residence times at those temperatures, and turbulent mixing of fuel and combustion air.

Fuel Combustion Characteristics/Volatile Organic Emissions (Cont.)

- Close similarity in combustion properties (e.g., flame temperature) between natural gas and COG

- Close similarity in VOC emissions between natural gas and COG:

Fuel	VOC Emissions (lb/MMBtu)	Reference
Natural Gas	5.4×10^{-3}	AP-42 (1998)
COG	2.3×10^{-3}	AIRS (1990)

- Extremely low volatile HAP emissions from natural gas and COG combustion

Particulate Matter (PM) Emissions

- EPA emission factors indicate that PM emissions from natural gas and COG combustion are typically low and similar in magnitude:

Fuel	PM Emissions (lb/MMBtu)	Reference
Natural Gas	7.5×10^{-3}	AP-42 (1998)
COG	1.2×10^{-2}	AIRS (1990)

Particulate Matter Emissions (Cont.)

- Reported HAP metal emission factors for natural gas are very low (10^{-6} to 10^{-8} lb/MMBtu) [(Reference AP-42 (1998)]

- Based on similarity in total PM emissions, analytical composition, and combustion characteristics between COG and natural gas, it is reasonable to assume that HAP metal emissions from COG combustion in process heaters or boilers are not significant.

Petroleum Environmental Research Forum (PERF) Project Results

- Under most operating conditions, a properly maintained gas-fired boiler or process heater produces exceedingly low levels of HAP emissions, typically near or below detection limits.

- HAP emission factors for boilers and process heaters fired by natural gas and refinery process gas are similar.

PERF Project Results (Cont.)

- The different compositions of natural gas and process gas appear to have a minimal effect on flame structures and HAP emissions.

- Burner design and NO_x emission control generally have no impact on HAP emissions.

Summary: The maintenance and operation of gas-fired combustion units have a far greater impact on HAP emissions than fuel composition.

Conclusion

The combustion of coke oven gas in well maintained/operated combustion units, such as process heaters and boilers, results in very low levels of HAP emissions similar to that of natural gas combustion.

Combustion emissions are specific to individual site and equipment parameters, including fuel type and quality, combustor type and design, operating conditions, control device operation, and maintenance practices. The formation and destruction of organic and inorganic pollutants in combustion systems, such as boilers and process heaters, is extremely complex. Many pollutant emissions result from the incomplete oxidation of complex organic species and reactions between precursors. Other pollutants, such as trace metals, may originate in the fuel, additives, or the combustion equipment itself.

The combustion of clean-burning fossil fuels, such as natural gas, typically results in the emission of only trace quantities of hazardous air pollutants (HAPs). These HAPs include volatile organic compounds, such as BTX (benzene, toluene, xylenes), aldehydes (formaldehyde, acetaldehyde), and PAHs, as well as trace metals, including arsenic, chromium, cobalt, lead, manganese, and nickel. Based on the reasons set forth below, the combustion of by-product fuels such as coke oven gas (COG) results in low levels of HAP emissions similar to that of natural gas combustion:

1. *Fuel Composition*:

Both natural gas and COG are comprised mainly of clean-burning gaseous components. Natural gas typically consists of 80-95% methane by volume, with much lesser quantities of ethane, propane, butanes, and other trace components. COG, following conventional byproducts recovery, generally consists mainly of hydrogen (typically 50-60% by volume) and methane (approximately 25-30%), with lower quantities of carbon monoxide, ethylene, ethane, propane, and other trace constituents. Analytical data indicate that volatile and semi-volatile organic HAP components, including hexane, benzene, toluene, xylene, naphthalene, and styrene, collectively comprise much less than 1% by volume of either natural gas or COG.

2. *Fuel Combustion Characteristics/Volatile Organic Emissions*:

The rate of trace organic emissions from combustion units varies with combustion efficiency. Organic emissions are minimized by combustion practices which promote high combustion temperatures, long residence times at those temperatures, and turbulent mixing of fuel and combustion air. Although COG has a heating value of about one-half that of natural gas (i.e., about 520 Btu/CF for COG and 1020 Btu/CF for natural gas), COG has a theoretical flame temperature (about 3600°F) which slightly exceeds that of natural gas. Furthermore, COG has a rate of flame propagation that is roughly double that of natural gas, which allows its actual peak flame temperature to be comparatively close to its theoretical flame temperature. This suggests that COG combustion efficiency is comparable to, if not greater than, that of natural gas, resulting in the efficient destruction of organic compounds in well maintained/operated combustion units. This is supported by VOC emission factor listings in the U.S. EPA FIRE/AIRS/AP-42 databases, which, when expressed on a lb/MMBtu basis, indicate close similarity between COG (2.3×10^{-3} lb/MMBtu) and natural gas (5.4×10^{-3} lb/MMBtu). Limited data on benzene emissions from COG combustion, as listed in the EPA FIRE database, further show close similarity to natural gas benzene emissions (i.e., 4.4×10^{-5} lb/MMBtu for COG and 2.1×10^{-6} lb/MMBtu for natural gas).

3. *Particulate Matter Emissions*:

EPA emission factors also indicate that filterable particulate matter (PM) emissions from natural gas and COG combustion are typically low and very similar in magnitude. The EPA AP-42 (Section 1.4) document lists natural gas combustion emission factors for HAP metals, ranging from the very low values of 2.1×10^{-3} lb/MMCF for nickel down to $<1.2 \times 10^{-5}$ lb/MMCF for beryllium. There are no known published trace metal emission factors for COG combustion. However, based on the similarity in total PM emissions, analytical composition, and combustion characteristics between COG and natural gas, it is reasonable to assume that HAP metal emissions from COG combustion are not significant.

4. *Petroleum Environmental Research Forum Results*:

Results generated by the Petroleum Environmental Research Forum (PERF) Project largely substantiate the similarity in HAP emissions from COG and natural gas combustion. Based on extensive industrial burner emission tests, theoretical chemical mechanism studies, and rigorous analysis of data from previous field studies, the PERF Project findings indicated that:

- Under most operating conditions, a properly maintained gas-fired boiler or process heater produces exceedingly low levels of HAP emissions, typically near or below detection limits,

- HAP emission factors for boilers and process heaters fired by natural gas and refinery process gas are similar (on a lb/MMBtu basis),

- The different compositions of natural gas and process gas appear to have a minimal effect on flame structure and HAP emissions, and

- Burner design and NO_x emission controls generally have no impact on HAP emissions.

In summary, the PERF Project results suggest that the maintenance and operation of gas-fired combustion units have a far greater impact on HAP emissions than the fuel composition. A properly maintained burner, within which organics are adequately mixed with oxygen at an adequate temperature, is, by design, a low HAP emissions burner.

***Conclusions**:* The combustion of COG in well maintained/operated combustion units, such as process heaters and boilers, results in low levels of HAP emissions similar to that of natural gas combustion. This conclusion is based on: 1) chemical composition data indicating that natural gas and COG typically consist mainly of clean-burning gaseous components, with minimal quantities of volatile HAPs and trace metals; 2) a similarity in combustion properties (e.g., flame temperature) between natural gas and COG, which suggests that, with either gas, good combustion practices will result in the efficient destruction of organic compounds; 3) EPA emission factor information, which indicates close similarity between natural gas and COG in total VOC, PM, and benzene emissions (expressed on a lb/MMBtu basis), and 4) recent findings from the PERF Project suggesting that the maintenance and operation of gas-fired combustion units have a far greater impact on HAP emissions than fuel composition and, under most operating conditions, a properly maintained gas-fired unit produces exceedingly low levels of HAP emissions.